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THE SEASONAL OCCURRENCE OF *IXODES DAMMINI* AND *IXODES DENTATUS* (ACARI: IXODIDAE) ON BIRDS IN A LYME DISEASE ENDEMIC AREA OF SOUTHEASTERN NEW YORK STATE

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Abstract.—A total of 310 birds of 41 species were examined for ticks during a 1 year study in a Lyme disease endemic area located in Westchester County, New York. Ticks were found on 28% (88) of the birds and 46% (19) of the species sampled. All of the 231 ticks found were immatures and all but 4 were either *Ixodes dammini* Spielman, Clifford, Piesman, and Corwin (51%) or *I. dentatus* Marx (47%). From May until September, *I. dammini* parasitized 36% of the birds of species found to host ticks and *I. dentatus* parasitized 26% from September to June. Based on the prevalence and seasonal distribution of ticks on birds at this site, we suggest that birds may be important in local and long-distance dispersal of *I. dammini* and thus also possibly important in the dispersal of the etiologic agent of Lyme disease.

Lyme disease, first recognized in the northeastern United States in Lyme, Connecticut (Steere et al., 1977), is caused by a spirochete, *Borrelia burgdorferi,* which is transmitted to humans primarily by the bite of an ixodid tick, *Ixodes dammini* Spielman, Clifford, Piesman, and Corwin (Burgdorfer et al., 1982; Spielman et al., 1985). This tick parasitizes a broad range of vertebrate species in the northeastern United States, particularly in its immature stages (Anderson and Magnarelli, 1980, 1984; Carey et al., 1980; Magnarelli et al., 1984; Main et al., 1982).

The intent of this study was to explore the role of birds as dispersal agents of ticks, particularly *I. dammini*, and consequently the etiologic agent of Lyme disease—*B. burgdorferi*—in a Lyme disease endemic area. Studies in Connecticut (Main et al., 1982; Anderson and Magnarelli, 1984) and Long Island (Good, 1973) have determined the presence of *I. dammini* on birds. However, none of these studies were conducted continuously throughout the year and none specifically addressed the movement of birds during all periods when they are parasitized by ticks. Our objectives were to determine what tick species parasitize birds in our area and what life stages of ticks are most prevalent on birds. We also studied the seasonal occurrence of tick species and stages hosted by birds and related this to bird movement. In addition, we ascertained if spirochetes were present in samples of ticks removed from birds.

MATERIALS AND METHODS

The study was conducted at the Louis Calder Conservation and Ecology Study Center of Fordham University, located in Armonk, Westchester County, New York.

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Hundreds of cases of Lyme disease in humans have been reported in the county since 1982 (Williams et al., 1986), including the Armonk site.

Fieldwork was conducted for 67 days between 15 May 1984 and 13 May 1985, averaging 5.5 days per month. Only during January were collections made less than one day per week. Birds were captured with Japanese mist nets and ground traps (McClure, 1984). Two nets were located in mature woodland, 4 at woodland ecotones, 3 in a late successional meadow, and 2 at winter feeder sites. Six ground traps were baited with bird seed and placed along roadsides in summer and at feeder sites in winter. Birds were banded and examined for ticks using 3.5× bifocal headgear. Ticks were removed with forceps from inside the ears and from areas around the eyes, bill, neck, and ears. Ticks were either preserved in 70% ethanol for later identification or were maintained alive for one to three days for spirochete examinations. Forty-one ticks were examined for spirochetes using dark-field microscopy (Anderson et al., 1983).

The mean number of ticks per bird was computed for the year for each bird species found parasitized by ticks (host species). Also, the mean number of ticks per bird was computed semi-monthly for all birds of host species. Bird species for which no parasitized individuals were found are excluded from these computations.

The common names for birds conform to the American Ornithologists' Union checklist (AOU Check-list Committee, 1982). Voucher specimens of ticks have been deposited at the American Museum of Natural History (*Ixodes*) and the Smithsonian Institution (*Dermacentor*).

RESULTS

A total of 251 birds of 41 species were examined, representing 310 captures and recaptures. Eighty-eight birds of 19 species were found to host ticks. This represents 28% of the total number of birds examined and 32% of 268 captures of host species. A total of 231 ticks representing 4 species were found parasitizing birds: *I. dammini, I. dentatus* Marx, *Haemaphysalis leporispalustris* Packard, and *Dermacentor variabilis* Say. This includes 117 *I. dammini* (40 larvae and 77 nymphs) and 110 *I. dentatus* (92 larvae and 18 nymphs). Table 1 shows species of birds hosting larval or nymphal *I. dammini* or *I. dentatus*. Not shown in Table 1 are three larval *H. leporispalustris* collected from one Swainson's Thrush and one larval *D. variabilis* found on a Gray Catbird. No adult ticks of any species were found on birds.

For all bird captures throughout the year, 54 (17%) hosted *I. dammini* and 39 (12%) hosted *I. dentatus*. For birds of host species only, 20% of the birds were parasitized by *I. dammini* and 15% by *I. dentatus*. However, from 1 May to 30 September, *I. dammini* were present of 36% of the birds of host species. Likewise, *I. dentatus* were present on 22% of the birds of host species from 1 March to 30 June and on 32% from 15 September to 31 December. Twenty-two bird species examined were without ticks (Table 2).

I. dammini larvae occurred on birds from May through September with a maximum average of 1.3 larvae per bird (of host species) recorded in late August. Nymphs occurred from May through July with a peak of 1.9 nymphs per bird in June (Fig. 1). *I. dentatus* larvae parasitized birds from March through May and from September through December, with peak mean values of 1.1 larvae per bird in April and 3.6

Table 1. Species of birds with *Ixodes* ticks (*Ixodes*) collected at Armonk, New York, May 1984–May 1985.

Species	Total birds (N)	Birds with ticks	Mean (standard error) ticks per bird			
			I. dammini		*I. dentatus*	
			Larva	Nymph	Larva	Nymph
Blue Jay	12	8	0	0.17 (0.11)	0.67 (0.19)	0.17 (0.17)
Black-capped Chickadee	66	6	0.05 (0.03)	0.02 (0.02)	0.09 (0.06)	0
Tufted Titmouse	25	6	0.08 (0.08)	0	0.32 (0.17)	0
Veery	1	1	0	0	2.00	0
Wood Thrush	13	7	0.31 (0.17)	0.23 (0.12)	0.08 (0.08)	0
American Robin	19	10	0.11 (0.11)	2.00 (0.88)	0.26 (0.21)	0.84 (0.51)
Gray Catbird	51	17	0.27 (0.12)	0.47 (0.16)	0.04 (0.03)	0
Blue-winged Warbler	1	1	1.00	0	0	0
Ovenbird	4	2	0.75 (0.75)	0	0.25 (0.25)	0
Canada Warbler	2	1	1.00 (1.00)	0	0	0
Northern Cardinal	2	1	0	0	1.50 (1.50)	0
Rose-breasted Grosbeak	5	3	0	0.60 (0.24)	0	0
Rufous-sided Towhee	3	1	0.67 (0.67)	0	0	0
Chipping Sparrow	15	6	0.33 (0.16)	0.13 (0.09)	0	0
Song Sparrow	12	7	0.08 (0.08)	0	1.33 (0.67)	0
White-throated Sparrow	8	6	0	0	5.00 (1.65)	0
Brown-headed Cowbird	1	1	0	2.00	0	0
House Finch	26	3	0.04 (0.04)	0.08 (0.05)	0	0
Total (18 species)	266	87				

larvae per bird in October. Nymphs occurred in May and June with a peak of 0.7 nymphs per bird in June (Fig. 1). Eight birds were hosts to both tick species simultaneously. Three birds had both larval and nymphal *I. dammini* simultaneously, and 2 birds had acquired larvae upon recapture within 30 days after hosting nymphs.

Thirty-six *I. dammini* (31 nymphs, 5 larvae), collected from June through August, and 5 *I. dentatus* larvae, collected in October, were examined for spirochetes. The ticks were removed from 20 birds of ten species, with 4 American Robins, and 5 Gray Catbirds hosting 24 of the 36 *I. dammini* nymphs. The remaining *I. dammini* were removed from 1 Blue Jay, 2 Black-capped Chickadees, 1 Tufted Titmouse, 1 Chipping Sparrow, 1 Song Sparrow, 1 Brown-headed Cowbird, and 2 House Finches. The *I. dentatus* were removed from 2 White-throated Sparrows. Six *I. dammini* nymphs from 3 American Robins were found to contain spirochetes, including 1 of 5 nymphs collected from a male on 14 June, 2 of 4 nymphs collected from a female on 20 June, and all 3 of the nymphs collected from a female on 13 July. No spirochetes were found in the sample of *I. dentatus*. However, spirochetes were found in a questing *I. dentatus* nymph collected during a concurrent study at the Armonk site (unpublished data).

DISCUSSION

Among the bird species with sample size of 10 or more, those parasitized by ticks most frequently include Blue Jay, Wood Thrush, American Robin, Gray Catbird,

Table 2. List of bird species found not to host ticks.

Species	Number examined
Mourning Doves	3
Black-billed Cuckoo	1
Ruby-throated Hummingbird	1
Eastern Wood-Pewee	1
Least Flycatcher	1
White-breasted Nuthatch	4
Ruby-crowned Kinglet	1
Brown Thrasher	1
Yellow Warbler	2
Magnolia Warbler	3
Black-throated Blue Warbler	1
Black and White Warbler	3
American Redstart	3
Worm-eating Warbler	1
Louisiana Waterthrush	1
Common Yellowthroat	1
Scarlet Tanager	1
Swamp Sparrow	1
Dark-eyed Junco	7
Northern Oriole	3
American Goldfinch	1
House Sparrow	1
Total (22 species)	42

Chipping Sparrow, and Song Sparrow (Table 1). These species are frequently found foraging on or near the ground. The absence of ticks from 22 species of birds may simply reflect small sample sizes or sampling during periods of low tick activity (Table 2). However, some species might not normally be parasitized due to ecological factors, such as infrequent occurrence of the bird at tick questing elevations or in appropriate habitats.

I. dammini comprised the majority (51%) of the ticks found parasitizing birds at this site. In a similar study conducted on Long Island, New York, Good (1973) found *I. dammini*, misidentified as *I. muris* (Spielman et al., 1979), to comprise 96% of the ticks found on birds. Also, Anderson and Magnarelli (1984) reported *I. dammini* to comprise 91% of the ticks found on birds in a Lyme disease-endemic area of Connecticut. Neither of these studies was continued into late October when peak numbers of *I. dentatus* larvae occur (Fig. 1).

In contrast, Sonenshine and Clifford (1973) found *H. leporispalustris* to be the dominant (57%) tick species parasitizing birds sampled from 11 banding locations operated along the eastern U.S. coast between 1965 and 1968. Similarly, Snetsinger et al. (1970) found this species almost exclusively (95–99%) on birds sampled in Ocean Co., New Jersey from 1965 to 1968. It is interesting that *I. dammini* (as *I. scapularis* or *I. muris*) was not reported in either of these earlier studies. Lyme disease is now endemic in Ocean Co., New Jersey and in 2 of the areas (Long Island, NY

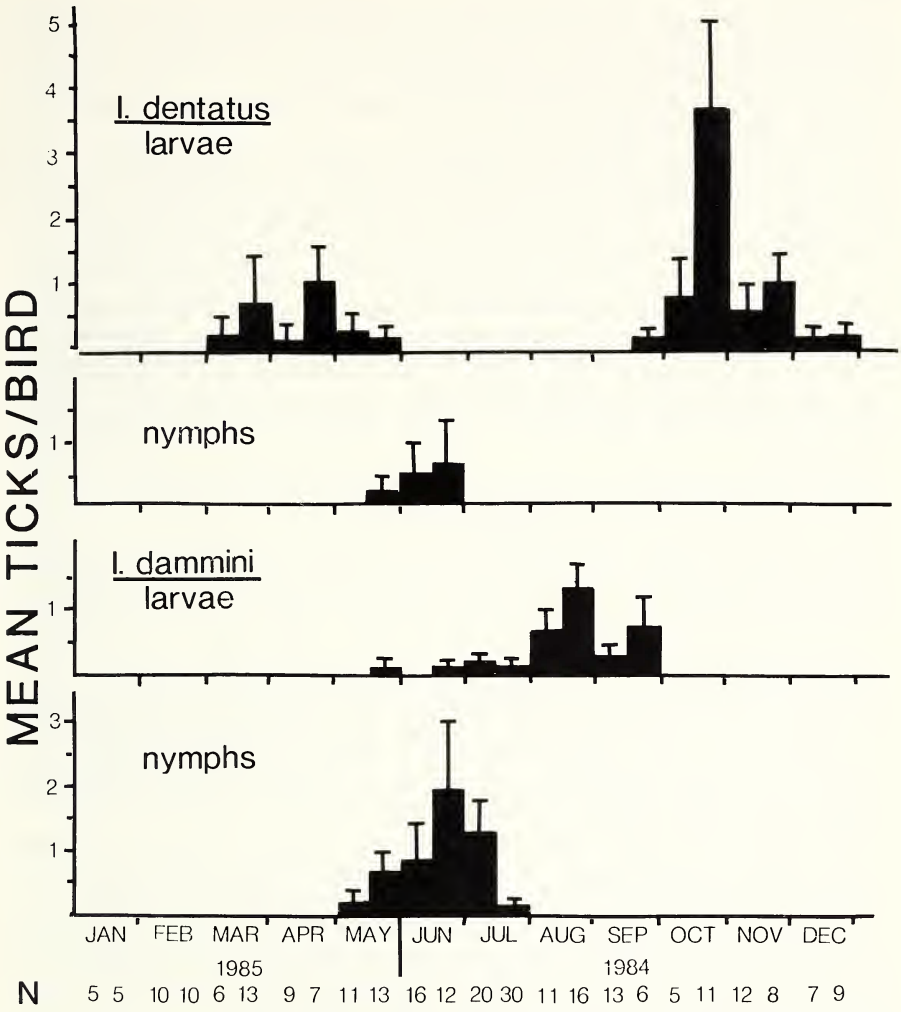

Fig. 1. Bi-monthly means (and standard error bars) of *I. dammini* and *I. dentatus* found on birds at Armonk, New York (N = sample size).

and Cape May, NJ) sampled by Sonenshine and Clifford (1973) (Hanrahan et al., 1984; Schulze et al., 1984).

The collection of a larval *D. variabilis* from a Gray Catbird is, to our knowledge, a new host record. Sonenshine and Stout (1970) found no *D. variabilis* on over 10,000 birds examined in North Carolina and over 700 birds examined in Virginia.

The seasonal occurrence of *I. dammini* on birds observed in this study closely parallels that which has been reported for mammals (Anderson and Magnarelli, 1980, 1984; Carey et al., 1980; Magnarelli et al., 1984). Data on the seasonal occurrence

of *I. dentatus* larvae vary somewhat from those of Sonenshine and Stout (1970) and Sonenshine and Clifford (1973) for the Piedmont and coastal areas of the eastern United States. In these studies nymphs occurred in April and May whereas in our study they occurred from late May through June. This delay may be due to the latitudinal difference between the sites.

Our data support the contention that birds may play an important role in local and long-distance dispersal of *I. dammini* and possibly also the causative agent of Lyme disease. During the breeding season, dispersal of *I. dammini* by birds may be limited to the breeding territory for most avian species. This territory varies in size within and among bird species. For example, territories of 0.4 to 1.2 ha for Gray Catbirds, 0.8 to 1.2 ha for Rose-breasted Grosbeaks, 0.2 to 0.6 ha for Song Sparrows and Chipping Sparrows, and 0.3 to 1.7 ha for Ovenbirds, have been reported (Stokes, 1979; Welty, 1979). Birds which might disperse *I. dammini* beyond confined breeding areas include Blue Jays, which do not have well-defined territories, and American Robins, which feed and roost extensively outside small nesting territories (Bent, 1949; Stokes, 1979).

After the breeding season, dispersal of *I. dammini* by migrating birds would be confined to the larvae because nymphs do not occur on birds after July and migration does not begin until August. Host species that migrate during the peak larval period are Blue-winged Warbler, Canada Warbler, Gray Catbird, and Rose-breasted Grosbeak (Bull, 1964). During the last 2 weeks of August, 3 of the 4 catbirds captured at the study site were hosts to larval *I. dammini*, with a mean load of 2.25 larvae per bird and a maximum of 5 larvae on one bird. Species migrating in September, when the larvae are still prevalent on birds, include the Veery, Swainson's Thrush, Ovenbird, Rufous-sided Towhee, Brown-headed Cowbird, and Blue Jay (Bull, 1964; Dolbeer, 1982; Treacy, 1985). These migration periods allow the southward dispersal of *I. dammini* larvae and may account for its apparent spread southward along the east coast (Spielman et al., 1984; Schulze et al., 1984).

Spring migration of birds would facilitate the northward dispersal of *I. dammini*. Nymphs begin to occur on birds in early May and increase in number throughout the migration period. In this study, host species which migrate in May include Ovenbird, Gray Catbird, and Rose-breasted Grosbeak. Veery, Wood Thrush, and Blue-winged Warbler are considered rare in New York State before May (Bull, 1964). Canada Warbler and Swainson's Thrush are likewise rare before mid-May with the latter migrating as late as early June (Bent, 1949; Bull, 1964).

In isolating *B. burgdorferi* from the liver of a Veery, Anderson et al. (1986) have demonstrated that birds may be suitable reservoirs for the Lyme disease spirochete. They indicated that infected larval *I. dammini*, which were removed from 6 species of birds, probably acquired the spirochetes from these hosts. The prevalence and seasonal occurrence of *I. dammini* on birds in our study suggests that the opportunity for horizontal transmission of *B. burgdorferi* to the next generation of *I. dammini* may be great because nymphs occur on birds both prior to and concurrent with larvae. Such horizontal transmission involving vertebrate reservoirs is essential for the maintenance of the spirochete in nature, but currently this role is attributed to the white-footed mouse, *Peromyscus leucopus* (Levine et al., 1985).

Birds would be important in introducing *B. burgdorferi* into new areas if they serve as reservoirs or if the spirochete can be acquired transovarially. Recent evidence

suggests that transovarial transmission of *B. burgdorferi* occurs rarely in *I. dammini* in nature (Piesman et al., 1986; Magnarelli et al., 1987). Spring migration of birds probably would be less important than fall migration because mostly nymphs are transported in the spring and these will parasitize medium-sized or large mammals after molting to adults. This may not result in the establishment of spirochetes in new areas, because most adults are temporally separated from immatures. Establishing new disease foci may require the dispersal of infected larvae which would occur during the fall migration. Only one larva was observed in the examination of forty birds of host species from 1 May to 15 June which suggests that northward dispersal of *B. burgdorferi* by *I. dammini* on birds would be minimal.

The presence of spirochetes in an *I. dentatus* nymph from a Lyme disease endemic area, together with the presence of larval *I. dentatus* on birds during spring migration, when nymphal *I. dammini* occur, would be significant if *I. dentatus* were a competent vector for *B. burgdorferi*. However, a mean of 0.3 larval *I. dentatus* per bird in May compared with 1.3 larval *I. dammini* per bird in late August would still result in a slower dispersal northward than southward.

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